MONTANA LIQUOR CONTROL BOARD

Final Report On

IBM Inventory Study

STATE OF MONTANA

LIQUOR CONTROL BOARD

FINAL REPORT ON

IBM INVENTORY MANAGEMENT STUDY

JULY 17, 1970

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SUMMARY OF RECOMMENDATIONS

The following list is a summary of the recommendations to be found throughout this report. Inherent in this report is the major recommendation resulting from this study: The Montana Liquor Control Board should plan to implement an IMPACT system for the most effective management and control of their inventory.

I. INTRODUCTION

This is the final report to the Montana Liquor Control Board concerning the IBM Service Estimate covering a study of the inventory control system at the Board. The original estimate was for a total of $6,720.00. The actual amount billed is the same figure of $6,720.00. The IBM Corporation wishes to express its appreciation to the Liquor Control Board for availing itself of IBM System Engineering Services during the past three and one-half months.

This report is designed to be a comprehensive presentation of the results, conclusions and recommendations relating to each area covered by the IBM Service Estimate. Of special importance in this report are the results of the Inventory Management Program and Control Techniques (IMPACT) portion of the study and the implementation plan developed as a result. The figures presented as a part of the IMPACT portion were derived from actual data supplied by the Liquor Control Board. The results show that, through the use of the IMPACT system, a substantial saving may be realized by the State of Montana, along with improved customer service, better control over inventory investment, and more timely management information.

The IMPACT implementation schedule has been designed based on the premise that it is important to achieve results swiftly. As a result, the schedule depends on each step being executed on time. If, because of unforeseeable circumstances, one or more steps should be delayed or advanced, the entire schedule would move accordingly. The entire schedule covers a period of four months, about two months less than would be the case under a more relaxed program. The success of this schedule depends greatly upon IBM involvement in carrying out the various steps.

The remaining sections of this report cover the areas of data collection, personnel training, related data processing applications, and coordination of the Liquor Control Board's data processing program with the overall State of Montana program. Portions of this report were first presented in the progress report of May 22, 1970 and are included here for the sake of completeness. As in that report, several charts are provided here to aid the reader as he covers the corresponding material.

II. PURPOSE OF INVENTORY MANAGEMENT

It may be argued that there are a multitude of reasons why any organization should employ an inventory management system. In any such discussion, however, three main reasons for such a system always emerge:

1. Provide better customer service
2. Minimize costs involved
3. Provide timely management information

Better customer service may be discussed in terms of "service level" as a percentage; that is, the percentage of demands which may be filled from available stock. At first, it may appear desirable to be able to fill 100% of all orders from available stock. Upon further investigation, however, it is discovered that this would require maintaining a very large inventory to guard against running out of any given item. On the other hand, it is possible to achieve a very high percentage of customer service and still keep the necessary costs at a reasonable level. This percentage will vary from one company to another, but a reasonable target to aim at would be 97% to 98%. Upon investigation of present operations, most companies will discover they are considerably below that level. Furthermore, those that are achieving a high service level are doing so at the cost of maintaining an excessively large inventory. In either case, a sound inventory management system would aid greatly in realizing a high level of customer service while, at the same time, reducing the costs to a reasonable level. Most companies find that the problem arises because they are unable, using manual methods, to determine the proper level of inventory for each item so they adopt some "rule of thumb" method which results in overstocking of some items and understocking of others. This "rule" actually determines service level. In contrast, a good inventory management system should allow management to choose this service level and then determine what "rule" must be followed in order to reach that goal.

As mentioned above, there are certain costs associated with managing inventory. Basically, these costs may be classified as "acquisition costs" and "maintenance costs". Acquisition costs (or purchasing costs) are those costs involved with ordering and receiving. Some of the factors making up purchasing costs are: a portion of the buyer's time, postage, forms and warehouse labor necessary to receive shipments. Of course, the cost of purchasing will vary as the number of orders placed varies. The other cost involved, maintenance cost, is also comprised of several factors, some of which are: cost of capital, insurance, storage, obsolescence, pilferage, and warehousing costs. Not all of these factors pertain to all

companies. In the case of the Montana Liquor Control Board, only the "cost of capital" is significant. This results from the fact that, if money were not invested in inventory, it could be released to the General Fund and result in a net savings to the State of Montana equal to 6% of that investment. Thus, the cost of maintaining inventory in the liquor warehouse is about 7% (6% plus 1% to cover all other areas) and it is this cost which becomes significant as service level is raised because it results in a larger investment in inventory. It may also be noted that a larger investment in inventory will result in less frequent ordering and produces a lower cost of purchasing. That is, these two costs actually rise and fall in opposition to each other. (Refer to Figure 1.) It is, then, an objective of an inventory management system to balance these costs and attempt to realize the lowest total cost.

The management information provided by an inventory management system must be timely. Management cannot effectively use information which is old by the time they read it. Some of the flexibility such a system should provide would be the ability for management to determine the outcome of policy changes in advance of actually trying them (such as increasing service level). The system should also provide management with the ability to monitor and evaluate the results of current policy. Also, management should be able to use this information to increase profits through sound policy decisions.

These, then, are the basic purposes of establishing an inventory management system. Since this system must be able to analyze each item, it becomes an almost impossible task when attempted on a manual basis. For instance, in the State of Montana, there are 151 State Liquor Stores. If each brand and size within each store is considered individually, this is the equivalent of 60,000 items! The power of a computer can and should be used to effectively control such a volume.

III. HOW THE IBM IMPACT SYSTEM ASSISTS IN INVENTORY MANAGEMENT

IMPACT is designed to be used as a tool by management to assist them in achieving their goals. The responsibility of setting policy and evaluating proposed changes rests with management. For instance, management may establish the desired service level and then let IMPACT perform the tedious calculations necessary to balance costs and determine how much stock to maintain in order to reach that service level. It may then be desired to examine the effects of changing service level. By repeating this process, management can determine how costs vary as service level is altered. A typical cost curve is illustrated in Figure 2. Notice how sharply costs increase as service level approaches 100%. This is the reason it is impractical to set too high a service level.

As IMPACT balances costs associated with a given level of service, it calculates the most economic quantity to purchase at one time and, based on historical usage, determines the number of times per year that item should be purchased. In other words, IMPACT is a tool to aid in determining "when to buy" and "how much to buy". In order to achieve these results, IMPACT makes use of proven statistical methods and historical data. It can thus forecast the demand for each item in the warehouse and compare that need against available stock. If it determines that there may be a stockout during the time interval for which the forecast was made, it will signal a need to order that item. However, management still has the ability to override IMPACT and change the order quantity or, indeed, not order at all. IMPACT also considers such factors as freight discounts, minimum and maximum order quantities and variability in demand when it selects the best ordering strategy. In fact, it goes even further and presents alternate ordering strategies, in addition to the most economical one, and lists the costs associated with each strategy. In this manner, then, management again has an opportunity to select that strategy which most appropriately fits their needs.

IMPACT also provides management the information necessary to monitor and evaluate the system. The ability is present to alter the system if the evaluation should show that the desired results are not being achieved.

Another major aspect of IMPACT is that it performs the routine calculations which would otherwise burden personnel. The result is that the buyer has more time to concentrate on other important considerations associated with purchasing. Moreover, while performing the routine, tedious calculations, a major source of error is eliminated due to the accuracy of a computer. It may be concluded that IMPACT provides the means with which management can effectively and consistently control inventory, stabilize costs, and maintain a high level of customer service.

IV. DETAILED REPORT ON IMPACT PORTION OF IBM'S INVENTORY STUDY

The following discussion describes the analyses performed by IBM during the course of this study. Alternate methods of performing inventory management were considered, and the need for an inventory manager. Many detailed calculations, based on data supplied by the Liquor Control Board, were necessary to arrive at the results presented in graphical form in Figures 9, 10, and 11. Every attempt was made to closely approximate the results which would be achieved if an IMPACT system were being utilized.

A. Comparison of Techniques

Several methods of inventory management were examined and the following ones rejected:

1. Manual System

   Due to the fact that a scientific method of inventory management necessitates an immense amount of routine, repetitive calculations, and that the number of items involved at the Montana Liquor Control Board is so large, this method was rejected. A manual system would result in a mammoth effort by Liquor Board personnel and would require a sizeable increase in staff to accomplish the goals of the Board.

2. The Production Information and Control System (PICS)

   PICS is a highly sophisticated system designed by IBM to perform the task of a complete inventory management system. However, it is designed to be used in a manufacturing environment. There is a section of it which could be modified and used for inventory management at the Montana Liquor Control Board. But, upon investigation, it was determined to be less flexible and not as desirable as IMPACT. PICS does not consider such things as vendor discounts, freight breaks, joint replenishment (to be discussed later in this section), and pooled shipments. On these grounds, then, PICS was rejected.

3. Consumer Goods System (COGS)

   COGS is IBM's most recent offering in the area of inventory management. In some areas, it is actually superior to IMPACT. However, COGS was designed to be used in a multi-level warehouse system. While the retail liquor stores could be considered as sub-warehouses, allowing the system to work, COGS must necessarily be used on a rather large computer

system. The investment in computer equipment necessary to run COGS has questionable justification at the Montana Liquor Control Board. As an example, a minimum computer system would be a System/360 Model 30 with 65,000 positions of core storage, three disk drives and two tape drives. Because of the resulting high equipment costs, COGS was rejected.

4. Personally Developed Computerized System

This type of system will generally result in a better control over inventory than a manual system due to utilizing the power of a computer. The degree of sophistication of such a system is a matter of personal choice. At a minimum, some "rule of thumb" is adopted such as "always order three months' supply". This type of rule will generally result in vastly overstocking some items while severe understocking of others would result. For the Liquor Control Board, more sophistication would be necessary if acceptable results were to be realized. Due to the seasonal fluctuations in the liquor business, a method to anticipate this change would have to be developed. Large savings due to freight discounts may be realized, but this could result in several hundred thousand dollars of excess inventory in the warehouse. Therefore, it would also be necessary to build in an analysis which would determine the additional costs incurred as a result and then weigh these costs against the savings due to freight discounts. In addition, consideration should be given to the item mix in an order, i.e. what percentage of a boxcar load should be allocated to the various items in that vendor line to assure an adequate time supply of each.

As is evident from the preceding paragraph, many factors must be considered in the development of a customized inventory management system. The amount of effort involved depends on the degree of sophistication desired. Of course, the amount of savings to be realized from such a system will depend directly on that effort.

IMPACT considers all of the aforementioned factors plus many more such as: vendor lead time, purchasing costs, desired service level, mean absolute deviation (a measure of error), review time, etc. Since this ability already exists in IMPACT, it would seem highly desirable to take advantage of this proven

system. To illustrate the effort expended in the development of IMPACT, the following quote from the preface of the IBM manual E20-0278 "Introduction to IBM Wholesale IMPACT (Inventory Management Program and Control Techniques)" is presented:

> "The IMPACT system was originally developed by IBM during 1961 and 1962, with significant support from members of the staff of the Arthur D. Little Co., Cambridge, Massachusetts. An invaluable contribution was also made by a number of distributors, representing six different types of organizations in the distribution industry who cooperated with IBM by testing and using the system during this period.
>
> The first version of the IMPACT system was completed and made available to other IBM users in February 1963. Since that time, a continuing development effort by IBM and Arthur D. Little has resulted in a series of significant improvements."

This statement illustrates the fact that a great deal of effort is necessary (literally man years) in the development of such a highly sophisticated system. Because that effort has already been made in IMPACT, it was decided to reject the idea of developing a personalized inventory management system.

B. Need for Inventory Manager

Early in the IBM study, the need for an inventory manager was discussed. Probably the key reason for the success of an IMPACT inventory management system is the existence of a responsible person to perform the function of inventory manager. Such a person would have the responsibilities of communicating with top level management, monitoring the IMPACT system, handling all inventory problems except those requiring action from top management, and training buyers and other affected personnel. This function may actually be performed by combining the talents of existing personnel, such as the data processing manager and the purchasing agent. In this manner, knowledge of purchasing may be combined with the knowledge of computer capabilities providing the necessary talents for a successful IMPACT installation.

C. Chronological Events in IMPACT Study

The following thirteen categories represent many of the steps which were necessary in order to reach the final conclusions. This discussion is designed to give the Board a feel for the types of considerations necessary in an inventory management system. Most of these categories represent data which would be used by an IMPACT system in the determination of the optimum ordering strategy. IMPACT has the ability to consider more factors than were used in this study, allowing for even greater refinement of control than presented in this report. The thirteen sections are:

1. Selection of Items

The sample chosen to work with was selected from the top 175 items as determined by one of the monthly distribution-by-value reports. These 175 items represent only 20% of the total items, yet they account for 80% of the sales. Out of these 175 items, 25 were chosen for detailed analyses. That is, one seventh of these top items were the object of investigation. A graph of the distribution-by-value report is attached. Recall that the 25 studied items were distributed throughout the top 20%. For the sake of completeness, the list of selected items is also included. (Refer to Figures 3 and 4.)

2. Seasonal Fluctuation of Demand

It became immediately apparent that almost every item in the warehouse was subject to seasonal fluctuations in demand. As may well be expected, the demand for liquor is very high in November and December due to the holidays at that time of year. Other factors affecting sales include the periodic price increases. Attached is a graph of a typical seasonal demand pattern (Figure 5). Notice that a straight line average may be established. This is known as the "deseasonalized demand". Also note that certain multipliers may be established mathematically such that, when the "deseasonalized demand" is multiplied by them, the resulting number will lie on the seasonal curve. Such multipliers are referred to as "base indices" and this is the method IMPACT uses when forecasting the need for the forthcoming period.

3. Joint Replenishment

When ordering products from a particular vendor (distiller), it is rarely the case that only one item number is ordered. Rather, the entire vendor line is

apt to be ordered. Since it is desirable in most situations to order a boxcar load at a time, the problem of allocation arises. That is, it must be determined what percentage of the load is made up by each item ordered. This method of replenishing stock in the warehouse is known as "joint replenishment". It has always been the practice of the Montana Liquor Control Board to use this method in order to obtain the freight discounts associated with such a policy. All indications are that a continuation of this policy is most advantageous. One of the desirable characteristics of IMPACT is its ability to handle the joint replenishment problem. In addition to the costs associated with joint replenishment, IMPACT will determine the costs when ordering items independently for those rare cases where that may be a more advantageous path to follow. Management may then make a policy judgment of which route to choose. The concept of "pooled shipments" may also be considered when multiple vendors are located at the same point of shipment or along the route of shipment. For purposes of the IBM IMPACT study, it was assumed that all orders would be on a joint replenishment basis and that all orders from a pooling point must be in the range from 40,000 pounds to 85,000 pounds. This did present a few extra problems since many calculations had to be done by hand, but it was felt to be worthwhile in that the results would more closely resemble those achieved by actually using IMPACT.

4. Purchasing Costs

Purchasing costs (or "acquisition costs") were described in the progress report as "those costs involved with ordering and receiving". It was pointed out that these costs are made up of several factors such as: buyer's time, postage, forms, cost of receiving, etc. These costs can be broken down into two basic costs - header costs and line costs. Header costs would be those associated with producing the heading on a purchase order. Throughout the Distribution Industry, a normal average for header costs is $1.00 per purchase order. The other cost (line cost) is comprised of those factors affecting the creation of each line in the body of a purchase order. An industry average for this cost is $.50 per line on a purchase order. For the study at the Liquor Control Board, the actual cost information was not available. At first, it was thought that a study should be performed to assure an accurate determination of purchasing costs.

Upon investigation through simulation, however, it was discovered that these costs could vary from the industry averages by as much as 100% and yet the resulting "net savings" would only change by 3%!

The amount of time which would have been required to perform such a study would not have been a wise usage at this time due to such a small fluctuation in "net savings". To emphasize that the resultant costs associated with purchasing are somewhat small, Liquor Control Board personnel ascertained that a total of 1,086 purchase orders were written over a one-year period and that there was a total of 7,174 line items on them. Thus, using industry averages, total purchasing costs for the warehouse was only $4,673.00. Even if these costs were doubled, the resulting $9,346.00 is a relatively small figure when compared against total annual sales. Thus, the decision was made, with approval of all concerned, to proceed with the study using the industry averages for header and line costs.

5. Maintenance Rate

Also of concern in an inventory management system are those costs associated with having an inventory on hand. A certain "rate" may be associated with carrying inventory called "maintenance rate". For the Liquor Control Board, the major factor in the determination of maintenance rate is "cost of capital" which was determined to be 6%. Several other factors would normally enter into a final determination of maintenance rate such as: taxes, insurance, depreciation/obsolescence, pilferage, breakage, warehousing, etc. Since most of these factors do not apply at the Liquor Board warehouse, it was decided to use 1% to encompass all of them. The resulting 7% maintenance rate may appear to be low, but it was felt that a conservative estimate would be more desirable in that a higher rate would result in an inflated figure for "net savings". If, in fact, the rate should be higher, the resulting increase in "net savings" may be considered a "bonus" over and above what could be expected.

6. Lead Time and Review Time

Lead time is determined by vendor and may be defined as that period of time elapsing between the day the purchase order is issued until the goods are received and put away. Mr. Leroy Battershell and data processing personnel gathered one full year's history in regard to date ordered and date received for all twenty-five items under study. This data was then

used by IBM to determine average lead time for each vendor. Lead time is one of the crucial elements used in forecasting future need as a determination must be made as to whether or not there is enough stock on hand to delay ordering and still maintain a specified service level.

Also of importance in a forecasting system is "review time" - i.e. the amount of time between buyer reviews of inventory. It is recommended that each item be reviewed for possible re-ordering on a weekly basis instead of on a monthly basis as is now being done.

Review time and lead time must be considered together in a forecasting system. For example, if review time is one week and lead time is three weeks, the inventory manager can answer the question: "If I don't order during this present review, how long would it be before we could receive that item?" The answer is four weeks, consisting of one week of wait time until the item is again reviewed and then three weeks of lead time. Thus, a forecasting system must be able to anticipate the demand over a "lead time" plus a "review time". Obviously, if the review time is large (say one month), then more stock must be kept on hand to cover the demand over a "lead time" plus a "review time" resulting in an inflated inventory.

7. Average Issues and Vendor Annual Issues

One full year of history for each item under consideration was compiled in order to obtain (for each item) the average monthly issues. This amount was converted into a cost dollar figure. By cost dollar figure is meant the amount it costs to buy and ship the product to the warehouse. Markup and out-bound freight were not included since any savings to be realized pertain to cost figures and not retail figures. This average was then used as the estimate of demand for the next period in order to forecast how much safety stock (to be defined in paragraph 9) must be maintained in order to meet the desired service level.

In order to simulate a joint replenishment operation, it was necessary to calculate total annual issues, in cost dollars, for each vendor and pool point under consideration. This "annual issues" figure enters into the formula for determining the most economical quantity to order at one time. This economical order quantity could then be subjected to the restriction that it must be in the range from 40,000 pounds to 85,000 pounds to determine the actual order quantity.

Once the actual order quantity was known, it was a simple calculation to determine the number of times per year that particular vendor would receive an order (a necessary quantity to determine future purchasing costs and freight costs). This number was obtained by dividing annual issues for the vendor by amount ordered at one time. Thus, annual issues were important in determining order quantity, purchasing costs, and freight costs, while average amount issued was needed to obtain a forecast of demand over the next period of concern.

8. Mean Absolute Deviation (MAD)

In any statistical analysis, some measure of error must exist. As far as forecasting is concerned, it is highly desirable to have some idea by how far actual demand may vary from that which has been forecast. In the IMPACT system, that measurement of error is MAD, which may be defined as the average amount (in absolute value) by which actual issues over a period of a year differed from average issues over that same time span. This method of measuring error was derived from, and bears a direct linear relationship with, the so-called "standard deviation" discussed in any standard statistical textbook. Therefore, use of MAD as a measure of error is based on a sound statistical foundation.

9. Average Inventory

Figures 6 and 7 should be used in conjunction with the following discussion. Average inventory may be described as being made up of two segments: that portion which would be issued if the average demand were always realized; and that portion which is kept on hand to act as a buffer in case of a variation from average demand. This latter "buffer" is safety stock and the amount required to be on hand is determined by the level of service established.

Examine more closely, then, the remaining portion of average inventory. Since it is the average amount on hand which may be expected to be issued, it must have some relationship with order quantity. The sum of all order quantities over a period of a year is just the total amount expected to be issued for a year. Naturally, when an order is first received, a full order quantity is on hand (in addition to safety stock). As time goes on, this quantity dwindles until it reaches zero (idealistically) on the day that the next order

quantity is received. At the halfway point in this cycle, exactly one-half of the order quantity has been issued and this is also the point at which the average on-hand is realized. Therefore, it follows that this portion of average inventory (excluding safety stock) is just one-half of an order quantity. This amount is termed "cycle stock".

The importance of cycle stock and safety stock is just this: when added together, they become average inventory. The reduction of this average inventory is one of the primary goals of an inventory management system. A reduction in either or both of cycle stock or safety stock, then, will achieve the goal. Since cycle stock is one-half the order quantity, it follows that ordering smaller quantities more often will result in smaller cycle stock. On the other hand, the cost of purchasing would go up and too small an order quantity would result in lost freight discounts. The prime purpose for safety stock is to allow for fluctuations from the average demand. The amount of safety stock will increase rapidly as service level is increased. It is this increase in safety stock that determines the increase in costs associated with high service levels (Refer to Figure 2.)

As is implied in the preceding paragraph, the problem facing an inventory management system is to balance offsetting costs to achieve the best ordering strategy, subject to the service level established by management. IMPACT provides the means to accomplish this end.

In the IBM study, it was necessary to determine present cycle stock and safety stock for the twenty-five items under analysis in order to make comparisons of the present system against an IMPACT system. Through the efforts of Mr. Leroy Battershell and his assistant, Mr. Ron Campbell, the necessary data was gathered to enable IBM to make these determinations. Present cycle stock for the twenty-five items was determined to be $174,306.00 and was arrived at by calculating one-half of average order quantity for each item over a one-year period. Safety stock was calculated as the average on hand at time of receipt and the results showed it to be $203,057.00. Upon adding these two quantities together, an average inventory of $377,363.00 was determined. This is the figure, then, against which IMPACT figures could be compared to ascertain net savings at the various service levels.

As a result of the determination of present safety stock, it was noted that these twenty-five items were completely out of stock 15% of the time. That is, for the period of time studied, these twenty-five items realized an 85% service level. This figure represents the only level at which true comparisons could be made. However, comparisons of IMPACT methods at higher service levels were made to indicate that present service level could be increased while simultaneously reducing the present average inventory, resulting in net savings.

In addition to average warehouse inventory for the twenty-five items, an investigation of total warehouse inventory, in cost dollars, was performed. Data for this analysis was very sparse in that such a report is only run twice a year, but the average from four such reports was $1,611,176.00 at cost figures. It is felt that this figure is actually low due to the times at which the report is run. One of the two runs per year is made on December 31 when the inventory should be somewhat depleted due to the large amount of holiday issues. Also, the fact that it is the end of a month tends to show a low on-hand amount. This is because the bulk of receiving is during the first part of the month, meaning that the end of a month would not represent an average on-hand amount in the warehouse. It is felt that $2 million would more closely represent average inventory in cost dollars for the warehouse under current operations.

10. Computer Program to Perform IMPACT Simulation

In the interest of saving time and guaranteeing accuracy of calculations, IBM developed a computer program which would closely approximate the results of using IMPACT. The main objective of this program was to determine what average inventory would be as a result of using IMPACT at various levels of service. The program was able to show present and expected purchasing costs, present and expected average inventory levels and corresponding decrease in average inventory, and was also able to calculate expected savings for these twenty-five items at the various service levels.

In keeping with the "rights in data" clause of the IBM Systems Engineering Service Agreement, this IBM produced program, as well as all pertinent data developed during this study, are the property of the Montana Liquor Control Board. Some of it may have future use, but it appears that much of this data was valuable only for the purpose of performing this study.

IBM developed a method to consider both inventory level and freight costs as an aid in determining the optimum number of times per year to order from a pool point. The results of this analysis showed that three basic patterns exist, depending on freight structure. Examples of the three patterns appear in Figures 12 through 14. These graphs illustrate freight costs, cycle stock costs, and total costs for these two factors. In Figure 12, the freight structure is such that a particular rate applies for the first 40,000 pounds of an order and a lower rate is applied to the excess over 40,000 pounds. By locating the minimum point of the "total cost" curve, the optimum number of times per year to order may be found. This will then establish the optimum amount to be ordered at one time. This optimum is then subjected to the restriction that it must be between 40,000 and 85,000 pounds. If it does not fall in this range, necessary adjustments must be made. At this point, then, a final determination of the amount to order may be made.

Figure 13 shows the pattern resulting from the freight structure on certain wines from California. In these instances, a discount is given at 64,000 pounds such that the entire shipment qualifies for a lower freight rate. As can be seen from the graph, the best ordering strategy is to order from these pool points the number of times per year resulting in exactly 64,000 pound shipments.

The structure illustrated in Figure 14 results from those shipments for which there is no additional freight savings for orders over 40,000 pounds. The optimum number of times per year to order is that number which results in exactly 40,000 pounds per order.

In all of the above examples, the cost of cycle stock follows the curved pattern illustrated by the dotted lines. The freight structure, then, is of major concern in determining the optimum number of times per year to order. Even though, it must be emphasized that freight costs are only part of the total picture in determining when and how much to order. Also to be considered are cycle stock, maintenance rate, purchasing costs, lead time, average demand, etc. All of these factors and more are considered by IMPACT.

11. Results of IMPACT Simulation

Determination of purchasing costs as they would exist under IMPACT showed that an increase of $381.00

per year over present purchasing costs would result for the twenty-five items being studied. These purchasing costs remained the same at all levels of service tested because purchasing is strictly a function of economical order quantity and does not depend on safety stock.

Also, as long as purchasing costs remained at $1.00 per header and $.50 per line, order quantity remains constant. Thus, cycle stock must necessarily remain constant since it is equal to one-half order quantity.

Due to ordering more frequently, the cost of freight increased from present levels by a total of $2,784.00 for the twenty-five items. This figure also remains constant at all service levels. Adding this figure to the increase in purchasing costs gives a total increase of $3,165.00.

Therefore, the only figure that varies as service level varies is safety stock. There is, in fact, a mathematical relationship between them. Briefly, a "service function" is calculated using order quantity, desired service level and MAD. From this "service function" a multiplier is established which, when multiplied by MAD, results in safety stock. It is this procedure that IMPACT uses to determine safety stock after management makes a policy decision as to what service level they desire.

The program discussed in Number 10 above was run using service levels ranging from 85% to 99%. At all levels, cycle stock was reduced from $174,306.00 to $118,251.00 (i.e. slightly over a 32% reduction). At 85% service level, safety stock was reduced from $203,057.00 to $11,423.00 for a reduction of $191,634.00 and resulting in a total reduction in average inventory of $247,689.00 for the twenty-five items. Applying the 7% maintenance rate yields $17,338.00 which can be considered savings. Subtracting the $3,165.00 increase in purchasing costs and freight costs gives a net savings of $14,173.00. Note that, even though $247,689.00 could be released to the General Fund, the resulting savings can only be considered as that amount it would have cost the State of Montana to keep that much excess inventory on hand at the liquor warehouse, i.e. 7% of the reduced inventory value.

As service level was varied to 90%, 95%, 97%, 98% and 99%, corresponding safety stock was necessarily increased and resulting savings were decreased. Recall once more that these figures were compared

against present operations with present service level. These results are graphically illustrated in Figures 9 through 11.

Although it is a management decision to establish the desired service level, the Board may wish to consider 95% or 96% as an initial goal and work up to 98% as time goes on. The advantage of this approach is to realize a substantial savings in a relatively short period of time while still maintaining a very respectable service level. For instance, Figure 10 shows that net savings for the twenty-five items at 95% is $10,657.00 while at 98%, the net savings drops to $7,790.00. This amounts to a difference of 27% in net savings for the privilege of raising service level only 3%.

One aspect that should be brought out again at this point is that, throughout the IMPACT study, a definite tendency toward conservatism was maintained. For instance, the 7% maintenance rate may in actuality be 1% or 2% too low. It was felt that conservative figures would be more desirable than entertaining the possibility of presenting inflated net savings figures to the Board. If, however, larger savings should actually result from using IMPACT, they could be considered an unexpected bonus.

Since reduction in average inventory and corresponding net savings shown so far have to do with only the twenty-five items under study, it would seem highly desirable to project these figures over the entire warehouse inventory. Such a projection cannot be made based on sound statistical methods due to the fact that the twenty-five items were purposefully selected from the top one hundred seventy-five items on the distribution-by-value report. Furthermore, it is not the intent of the IBM Corporation to imply, express, or promise a specific total dollar savings which may be realized by the State of Montana as a result of installing an IMPACT system. It is possible, however, to make a restricted projection over those items marketed by the distillers involved with this study. Since the test items were chosen from the top 175 items on the distribution-by-value report, it was from this group that the items were chosen over which the projection could be made. All items out of this group of 175 which were associated with the distillers under examination were grouped together for further analysis. There was a total of 112 such items coming from 17 distillers. Necessary data for these items was assembled and another program was written to assist

in the projection analysis. This data was then punched into cards and assembled by distiller. The computer program was able to determine the amount of weight and dollar volume associated with each distiller and for each item over a one month period. From this data, the program was able to determine the percentage of dollars and percentage of weight accounted for by those test items in each group. Knowing this percentage allowed the projection to be made. A service level of 95% was chosen to be used in the analysis.

The results of the projection show a reduction in average inventory of $566,600.00 can be expected. Applying the 7% maintenance rate yields a savings of $39,662.00. However, as indicated earlier in this report, higher costs of purchasing and higher costs of freight are predicted. These costs were also projected and the results showed a projected increase in purchasing costs of $1,095.00 and an increase in freight costs of $4,740.00. When these two costs are subtracted from the above mentioned savings, a projected net savings of $33,827.00 is arrived at.

Using $2 million as the average warehouse inventory in cost dollars, the $566,600.00 reduction represents a decrease of 28.3%. This shows that a substantial reduction in inventory may be achieved while simultaneously raising service level to 95%. The results of this projection are summarized in Figure 15.

12. Results of Contact with Ohio and Oregon

IBM personnel made contact with an IBM Representative in Ohio and with Oregon Liquor Control Commission personnel in Oregon. Both of these states are control states using IMPACT. Ohio has only been using IMPACT for about three to four months. According to the IBM Representative in Columbus, who installed the system and still services the account, Ohio is realizing a 30-40% improvement as far as computer time is concerned to perform the necessary inventory analyses. Ohio's own system was somewhat sophisticated and did, indeed, make use of sound statistical procedures. Even at that, they are anticipating at least a 17% reduction in average inventory by using IMPACT.

Ohio, however, is not a reasonable state to compare against Montana in that their liquor business is much larger. For instance, they have five districts (each of which has its own warehouse) servicing the state.

The average inventory over all five warehouses is in the neighborhood of $42 million, making it considerably higher than that in the State of Montana. The only fact that is significant is that a reduction in average inventory is expected as a result of using IMPACT.

Oregon, on the other hand, more closely resembles Montana. The man with whom contact was made is Mr. Bob Dancer of the Oregon Liquor Control Commission. The following information was obtained from him:

a. Oregon has 180 retail outlets.

b. Retail store managers are professional managers and not subject to replacement as the administration changes.

c. Oregon started on IMPACT in 1967.

d. They used a 6% maintenance rate and are now considering increasing it.

e. Review time is one week.

f. Oregon does not use IMPACT to control inventory at the retail level.

g. The warehouse was able to reduce average inventory by $800,000 after installing IMPACT.

h. Oregon tried for a 99% service level. They are currently attaining a little over 98%.

i. Retail sales have increased substantially since 1967.

k. Mr. Dancer could not recall what average inventory was at the time the $800,000 reduction was realized.

l. Number of warehouse turns has almost doubled since installing IMPACT.

m. Oregon uses the "forced sales" technique of determining sales at the retail stores.

n. A system is currently under development to more closely control inventory at the retail stores.

Mr. Dancer is an extremely cooperative individual and is quite willing to discuss his IMPACT experiences with officials from the State of Montana. He may be reached by phoning Area 508/654-7741.

13. Plan for Inventory Control At The Retail Stores

It was recommended in the progress report of May 22 that control of ordering for the retail stores remain with the warehouse. One reason given was the amount of training which would result if each store manager had to determine "when to order" and "how much to order" for each item in his store. Also of major importance is the fact that many different policies would result instead of one under centralized control. It is, therefore, once more recommended that this control remain with the warehouse.

A detailed system has been designed, for use at the warehouse, which will forecast the need at the retail stores and also forecast the amount of that item which is expected to be ordered from the warehouse over the next month. This latter amount may be used as the forecast of demand as far as the IMPACT system at the warehouse is concerned. Two problems exist with this approach.

a. To accurately forecast need at the retail stores, past history of public demand must be available. The history which is available is that of actual sales to the public and it appears unrealistic to attempt to record actual demand. Sales may be used to do this forecasting so long as adjustments are made to compensate for their use. The results of using sales data to forecast (rather than demand) is ordinarily to forecast too low. Depending upon past history of outages, that forecast could then be adjusted upwards as the compensation. The mere knowledge that this problem exists means that steps may be taken to overcome it.

b. The other problem is one of timing. It would be highly desirable to delay the use of such a sophisticated system at the retail level until after the system at the warehouse level has been installed and perfected. An interim approach would be to establish an "order point-order quantity" technique for initial use at the retail level. Such a system would establish a certain level of inventory for each item at each store. This level is order point. Then, when available inventory falls below the order point, an order would be triggered for one "order quantity" of that item.

The order quantity would be established using the economical order quantity formula found in IMPACT. With this technique, no attempt would be made to forecast demand on the warehouse from a retail point of view. Rather, such demand would be forecast using the normal IMPACT approach of basing it on past history. This type of approach would be much easier to install at first than the sophisticated system mentioned above. Then, as the IMPACT system in the warehouse is perfected, the more sophisticated system could be introduced to control inventory at the retail level. A reasonable length of time to delay would be three to six months after formally starting IMPACT at the warehouse.

As a result of investigating data supplied by Liquor Board personnel, it was found that more inventory exists in the retail stores as a conglomerate than in the warehouse. This is as it should be. However, in several instances, it was found that as much as six times more inventory exists in the retail stores than in the warehouse. This emphasizes the need for control over the retail inventory as well as the warehouse inventory.

D. Summary of IMPACT Portion of Study

The IBM Corporation has considered several methods of accomplishing inventory management. It is recommended that the Montana Liquor Control Board install an IMPACT system to accomplish this goal.

The necessary Liquor Control Board personnel should be trained in the techniques of IMPACT.

Many detailed calculations were performed in order to attain meaningful comparisons between the present system and an IMPACT system. It was determined that sizeable dollar savings could be realized while simultaneously increasing service level. A need for control over the inventory at the retail level was ascertained and the fact that overall control of ordering should remain with the warehouse was recommended.

It may seem that IMPACT would demand a great deal of time to use on a day-to-day basis. Such is not the case, however. IMPACT may be viewed as two systems; an initializing system and an operational system. The initializing system is used once or twice per

year and it is here that calculations are made to determine base indices, MAD, lead time, lead time variability, initial forecast of demand, certain constants resulting from studies, and other factors which would not change throughout the year such as ordering strategy, forecast model (seasonal, trend, horizontal), etc. To give the Board an idea of the amount of time involved annually for re-initialization, the State of Oregon requires 16-24 hours per year to perform this task on their computer.

The other portion, the operational system, is the one which would be run on a day-to-day basis. Quantities such as MAD, forecast of demand, and base indices are updated to reflect the most current information. This is accomplished through the use of exponential smoothing, which adds to (or subtracts from) the previous period's quantity, an adjustment factor. As an example, suppose the old estimate of demand was 100. Suppose further that the actual demand over the same period had been 120. The following calculation would then be performed: .1 X (Actual demand - Old estimate of demand). The .1 may be changed, if desired, to put more emphasis on recent history. Inserting the numbers described above yields:

$$\begin{aligned} \text{Adjustment Factor} &= .1 \times (120-100) \\ &= .1 \times (20) \\ &= 2 \end{aligned}$$

This adjustment factor would then be added to the old forecast to give:

$$\begin{aligned} \text{New Forecast} &= 100 + 2 \\ &= 102 \end{aligned}$$

Using this technique of exponential smoothing, it is not necessary to go back and perform the analysis required to produce the original forecast.

The operational system would then perform the necessary calculations to determine if it is time to buy that item. This procedure is repeated for each item under consideration. As an example of the amount of time this takes, Oregon estimates between 15-24 hours of computer time per month is attributable to IMPACT. It should be noted, however, that their computer system does not have the same units as the Liquor Control Board's system.

It is true then that, while it performs a tremendous service, IMPACT is actually very easy to use on a day-to-day basis. This opinion is also shared by Independent Wholesale Grocers in Billings, Montana, who have been using IMPACT since the first of February, 1970. The greatest effort is in the implementation phase due to the fact that various factors must be determined initially and a great deal of planning and data gathering are necessary prior to the time the aforementioned "initialization system" may be used.

It is also true that IMPACT may be implemented on the IBM 1440 Computer System presently installed at the Liquor Board warehouse. Certain problems exist which may be of major concern if the Board should choose to retain the 1440 system.

When IMPACT is used on the 1440 system, it is necessary for the user to program his own routines to perform the aforementioned exponential smoothing. He must also provide the necessary routines to update base indices, MAD, and calculation of economic order quantity (when adding new vendor lines to the system).

These problems will not exist should the Board decide to acquire a System/360 computer system. Of special interest is the programming problem mentioned above. As one of the refinements of IMPACT in recent years, IBM has developed a set of pre-written routines (called macros) to aid the programmer in his efforts. These macros perform the exponential smoothing, updating of base indices, etc., which means the programmer does not have to become proficient in mathematics and statistics. While it is true that both the 1440 system and the System/360 may be utilized to run IMPACT, it becomes a simpler task on the System/360.

V. ACCUMULATION OF APPROPRIATE DATA

In order to install an IMPACT system, a great deal of historical and current data is needed. By far, the greatest bulk of this data is presently available in the data processing department at the Montana Liquor Control Board. Certain other data and information must be available before actual implementation can be effective. The areas of concern are:

1. Demand Data

   As previously mentioned, better results will be obtained by using "demand" instead of actual sales data. It is, therefore, recommended that, as an order from a retail store is processed, the full amount ordered (demand) be recorded on disk as well as the amount actually issued. This leads to the question of back ordering to account for that portion of an order which cannot be filled from available stock.

2. Back Order Data

   It is recommended that a back order procedure be established whereby the computer can "remember" how much of each item a retail store requires to fill a previously unfilled need. The amount to place on back order is just the difference between the amount ordered and the amount shipped. Then, when the warehouse receives that item from the distiller, the amount on back order may be automatically shipped to the retail store requiring it. This would require the establishment of a back order file (probably on disk) to keep track of any such items.

3. Vendor Data

   Certain data should be acquired for each vendor (distiller). It should be determined if a vendor allows a discount for quantity orders and, if so, how much. The discount structure for freight breaks should be defined for each vendor. Both the break point and amount of discount should be determined. Another type of vendor data needed is lead time data. A study should be performed as part of an implementation schedule to determine average lead time for each vendor and also what variance from the average exists.

4. Accurate Determination of Purchasing Costs

   In the event that the Board should wish to determine purchasing costs in the Montana operation instead of using industry averages, it would be necessary, during implementation, to perform the appropriate study.

Information needed would be: cost of forms, cost of postage, cost of checks used to pay vendors, and a breakdown of certain personnel's time which should be attributable to purchasing costs.

5. Expansion of Present Disk Record

It will be necessary for the data processing department to examine the present layout of the disk files. Upon implementation of IMPACT, additional space will be required to retain demand data, base indices, current service level, average inventory, amount on back order, MAD, and current forecast of demand for each item in the warehouse. The present disk record for warehouse items does not contain adequate space to facilitate the addition of this amount of data. Two courses of action are available. The present record could be altered or expanded to accommodate the additions. This would result in a disruption of the current data processing activities while those programs currently accessing the disk are altered. Alternatively, an additional file could be utilized which would contain the additional information. This file would not be needed in the present operation and so would not disrupt current operations. It could be used when needed to perform IMPACT related operations. This file could take the form of a card file, magnetic tape file, or an additional disk file.

Most of the data described above should be acquired during the initial portion of an implementation phase. The capturing and retention of demand data, however, should begin as soon as possible since this would produce a greater amount of that type of history when IMPACT is ready to be run as a routine program.

VI. EDUCATIONAL REQUIREMENTS

If an IMPACT system is to be successfully installed at the Montana Liquor Control Board, it will be necessary for certain Board personnel to be trained in the techniques to be employed. Those persons performing the job of inventory manager must gain an in-depth understanding of IMPACT. To accomplish this end, they should attend the IBM IMPACT Implementation class and, in advance, read two introductory manuals produced by IBM (GE20-0278 and GE20-8105) which would give them a solid introduction to IMPACT and enable them to acquire a deeper knowledge and understanding during the implementation class.

These people would be responsible for any necessary familiarization of other Liquor Control Board personnel such as the retail store managers. The data processing manager would be responsible for training his people to the extent necessary to operate the system. IBM may be called upon for assistance in this training program.

These educational goals are realistic and attainable. Yet, they are the key to success in a plan to install IMPACT and, more importantly, in its continued use as an effective means of providing inventory management.

VII. IMPLEMENTATION SCHEDULE

Of major importance in the installation of an IMPACT system is a comprehensive plan. Planning, then, should be the first step in an implementation program followed by actual development of a tailored IMPACT system for the Montana Liquor Control Board. It is primarily in this planning phase where IBM assistance can be extremely valuable to the Liquor Board. With this in mind, then, the implementation phase may be divided into two major categories:

A. Efforts requiring both IBM and Liquor Control Board involvement.

B. Efforts requiring only Liquor Control Board involvement.

Part A consists of ten steps. Notice that some of the steps are just the data accumulation described in Section V above. It may be entirely possible to shorten or eliminate some steps depending on findings as the planning phase progresses. All ten steps are presented here with an estimate of necessary calendar working days.

Step Number	Description	Calendar Days
1	Define present system	3
2	Establish procedure to obtain all data other than demand data	5
3	Design operating system	16
4	Determine purchasing costs	6
5	Design stockout report	2
6	MAD vs time study	6
7	Lead time variability and book error study	10
8	Review and refine operating system	10
9	Test programs using two or three vendors and make revisions	20
10	Documentation and weekly reviews	Continuous
	Total	78 Days

Part B activities would be performed during the same calendar time as Part A and would involve only Liquor Control Board personnel. The following schedule was prepared assuming July 1 as a starting date for implementation.

Step Number	Description	Duration
1	Monitor present system during planning phase-service level, number of turns, average inventory	07/01 - 11/02
2	Attend IBM IMPACT Implementation Class	07/13 - 07/23
3	Code all necessary programs	08/18 - 10/05
4	Buyer familiarization	07/27 - 10/05
5	Establish contact with other IMPACT users	07/27 - 10/05
6	Order necessary forms	09/21 - 10/05
7	Operator training	09/21 - 10/05
8	Store manager familiarization	10/05 - 11/02
9	Make policy decisions such as desired service level	10/15 - 10/16
10	Liquor Control Board to oversee entire project	07/01 - 11/02
11	Administrator to keep Board apprised of progress	07/01 - 11/02

The above schedule is shown commencing on July 1 for illustrative purposes only. The important point to note is that it spans a period of four months. It is necessary for the IMPACT implementation class to be attended early in the schedule or entirely before it begins. The four month schedule may be realized provided each step is performed on time.

This schedule is shown in bar chart form in Figure 8. Notice that attendance at the class must precede finalization of systems design and commencement of coding. It would be possible, however, to attend the class sooner in the schedule or, as mentioned above, entirely before the schedule.

The next implementation class is scheduled in San Francisco on August 24. Further classes will be held this fall, but a schedule showing starting dates is not yet available.

There are two reasons why the Board may wish to set a later date than August 24 as a target date to begin implementing IMPACT.

1. Possible Equipment Change

   If the Board should decide to change the computer system, it would be most desirable to effect that change before undertaking any new applications such as IMPACT. Then the IMPACT system and the other suggested applications could be designed for the new system, resulting in a smoother transition.

2. Date of Actual Running of IMPACT

   Since November and December are the busiest months of the year for the Board, it may be unwise to add a brand new application of this magnitude at that time of year. A substantial portion of the initial phases, though, could be completed during November and December, especially those portions with high IBM involvement. The target date for actual implementation could be, say, January 15 or February 1, meaning initial work should commence in September or October. In this case, it would probably mean attending the implementation class in September, October, or November, depending on when the most convenient class is scheduled.

VIII. RELATED DATA PROCESSING APPLICATIONS

During this study, IBM considered various additional applications which may be incorporated into the data processing procedures at the Liquor Board. Many of these applications deal directly with inventory management information while others are concerned with related areas. Basically, there are two areas to consider: additional reports and data entry.

A. Additional Reports

The following information is recommended to appear in additional reports to the Board:

1. Current service level.
2. Number of warehouse inventory turns per year.
3. Average warehouse inventory expressed both in cost and retail dollars.
4. Demand on the warehouse and actual issues.

The above items can appear on new reports or they may be incorporated into existing reports. This information is invaluable in the evaluation of day-to-day operations at the Board. For instance, current average inventory could be compared to that level one year ago to ascertain increase or decrease. Similarly, service level and number of warehouse turns may be monitored to assist the Board in the monumental task of managing the liquor business in the State of Montana.

For each store, a monthly report should be prepared showing the number of times physical inventory differs from computer maintained inventory and by how much. It should also show the date of last discrepancy. The value of this information is to allow the Board to detect consistent errors and take corrective action to improve the situation. This would also give the Board a tool with which to measure the performance of the stores.

A back order procedure should be implemented. This would allow previously unfilled orders for the retail stores to be automatically filled when the shipments arrived from the distiller, thereby reducing the length of time a retail store must be out of a particular item.

The computer should be used to assist the Board in determining the value of listing a new item. For example, when a new item is proposed to the Board for listing, the

computer could print out all similar items, showing case volumes, annual sales, cost and profit.

Furthermore, when the Board establishes criteria for listing items, the computer should be used to periodically print all items currently failing to meet the listing criteria. Then the Board would have much more factual information upon which to base a delisting decision.

Currently when major price changes occur, a card file is manually updated to reflect the new prices. A program should be written to enable the computer to perform this task. Since the formulae for computing the retail prices are already established, the effort required to produce such a program should be minimal. Thereafter, any price changes could be accomplished by merely entering the item identification number and the new cost price. The computer would then update the old record to reflect the change, calculating the new retail price in the process.

B. Data Entry

The field of data entry is one in which a great deal of streamlining may be realized. The benefits of such a streamlining are: reduced personnel requirements, reduction of errors and corresponding computer reruns, increased controls over cash balances, and a single source document being used as input to inventory analysis, cash balancing, retail stores analysis and sales analysis. This may be accomplished by using the sales slip as the source document mentioned above.

Under current operations, the information from each sales slip is recorded on a summary sheet in the retail stores. That summary sheet is then sent to Helena where it is used as a source document from which cards are punched. Each time this data is transferred from one medium to another, an opportunity for error exists. Also, by using the summary sheet, it becomes extremely difficult to trace down the actual source of any errors. Furthermore, this transcribing of data requires a significant amount of time, resulting in high personnel costs.

There are two methods by which the sales tickets may be used as source documents:

1. The sales tickets may be forwarded to Helena, where cards may be punched from them. These punched cards would then be read by the computer and the various analyses mentioned above performed.

2. Certain machines exist called "Optical Character Recognition" equipment (OCR) which have the ability to read handprinted numerals and machine printed characters. If the sales slips were slightly modified for machine scanning, they could be read directly into the computer with no intervening transcription of data necessary.

In either case, the primary concern is to use data in its original form if at all possible. Because OCR equipment enables this goal to be achieved, it is recommended that the Board investigate the feasibility of acquiring such equipment.

IX. COORDINATION OF THE LIQUOR CONTROL BOARD'S DATA PROCESSING PROGRAM WITH THE OVERALL STATE OF MONTANA PROGRAM

In an organization such as State Government, it is desirable to coordinate data processing efforts among the various departments in the interest of achieving a more uniform operation. For instance, one department may require the talents of an individual from a different department. To use this person's talents and background may eliminate the need to hire a new man. Also, certain budgetary information is required from all departments. If one of these departments should desire to utilize a computer for the gathering and maintaining of that information, it would seem advantageous to use methods already developed by other departments for this purpose. This would reduce duplication of effort among the State employees. Furthermore, should the State of Montana desire to centralize certain data processing functions, standards should exist in each department to regulate the accumulation of necessary data.

It is therefore recommended that an avenue of communication be established to facilitate the free interchange of data processing techniques and ideas between the various agencies utilizing data processing equipment. As a result of this communication, the State could anticipate a reduced duplication of effort due to better utilization of the available resources.

X. SUMMARY OF IBM INVENTORY STUDY

The IBM inventory study for the Montana Liquor Control Board has been brought to a conclusion. During the course of the study, each area of the original IBM Service Estimate has been considered. Results and recommendations have been presented in this final report. The results show that a definite benefit may be realized by advancing to a program for the implementation of an IMPACT system at the Liquor Control Board. Furthermore, certain related data processing applications have surfaced as a result of this study.

It has been shown in this report that substantial dollar savings may be realized through the use of IMPACT while simultaneously raising service level. Additional benefits include tighter controls over inventory and more timely management information. It may be recalled from Section II of this report that these points are the main reasons for developing an inventory management system in the first place.

In addition, a comprehensive schedule for implementation has been presented which shows that an IMPACT system could be installed and operational in approximately a four month period. As indicated in that schedule, certain tasks would require the assistance of IBM personnel. An IBM Service Estimate showing the amount of IBM involvement necessary and the resulting cost to the Liquor Control Board has been prepared. It is recommended that this Service Estimate for an IMPACT implementation project be authorized by the Board.

As previously mentioned in this report, all originally produced material and data resulting from the IBM inventory study (including computer programs, systems design for controlling inventory at the retail level and all related documents) are the property of the Montana Liquor Control Board. This is in keeping with the "rights in data" clause of the IBM Agreement for Systems Engineering Services.

Once more, the cooperation and assistance received from Liquor Control Board personnel has contributed greatly to bringing this study to a swift and successful conclusion.

IBM is looking forward to being of service to the Board during an implementation phase, and it is anticipated that this fine spirit of cooperation will enable that phase to be highly successful and profitable to the State of Montana.

Submitted By:

E. P. Meck
Associate Systems Engineer
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Approved By:

R. D. Pendl
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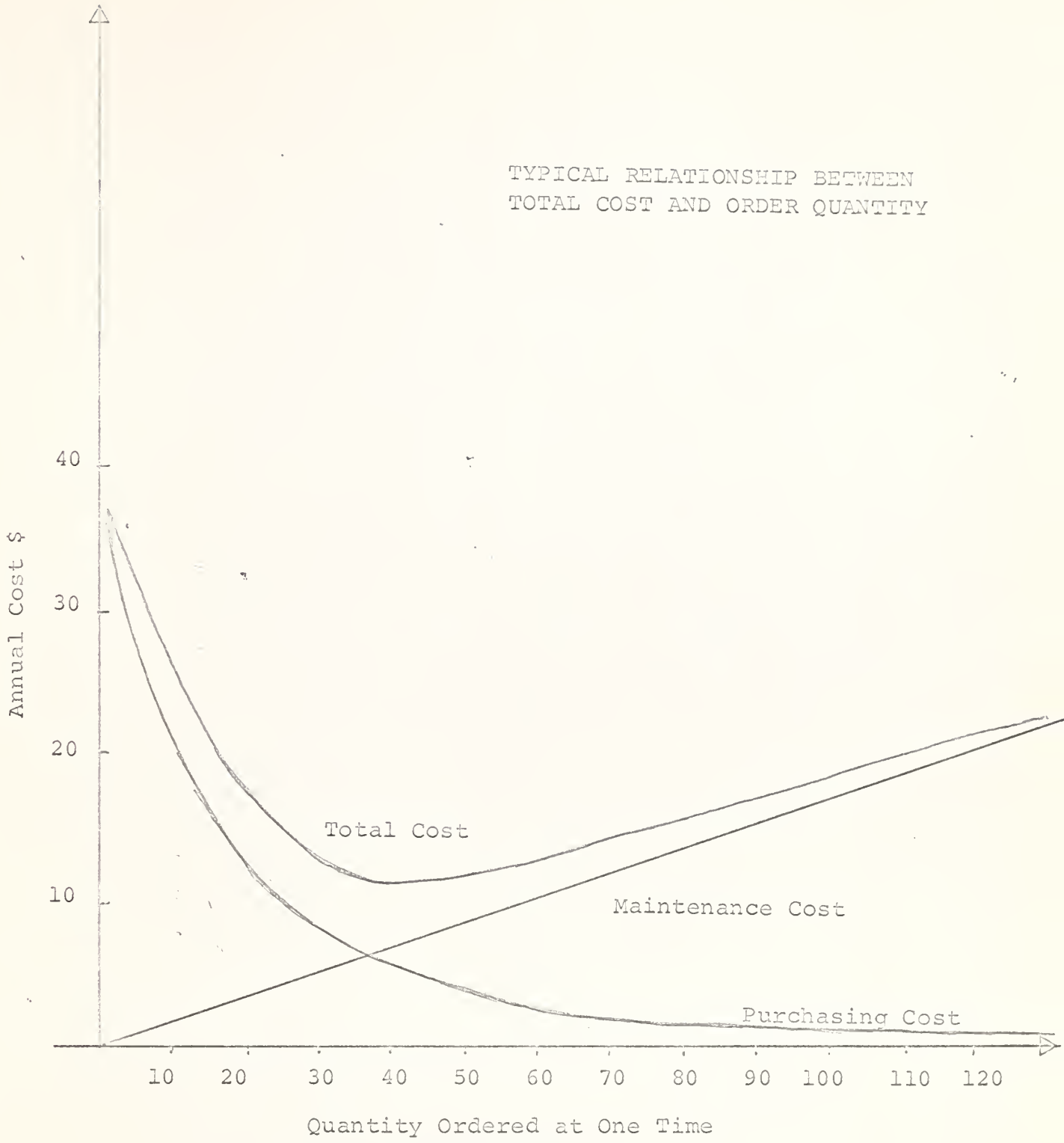
TYPICAL RELATIONSHIP BETWEEN
TOTAL COST AND ORDER QUANTITY
Annual Cost $
40
30
20
10
Total Cost
Maintenance Cost
Purchasing Cost
10
20
30
40
50
60
70
80
90
100
110
120
Quantity Ordered at One Time

FIGURE 1

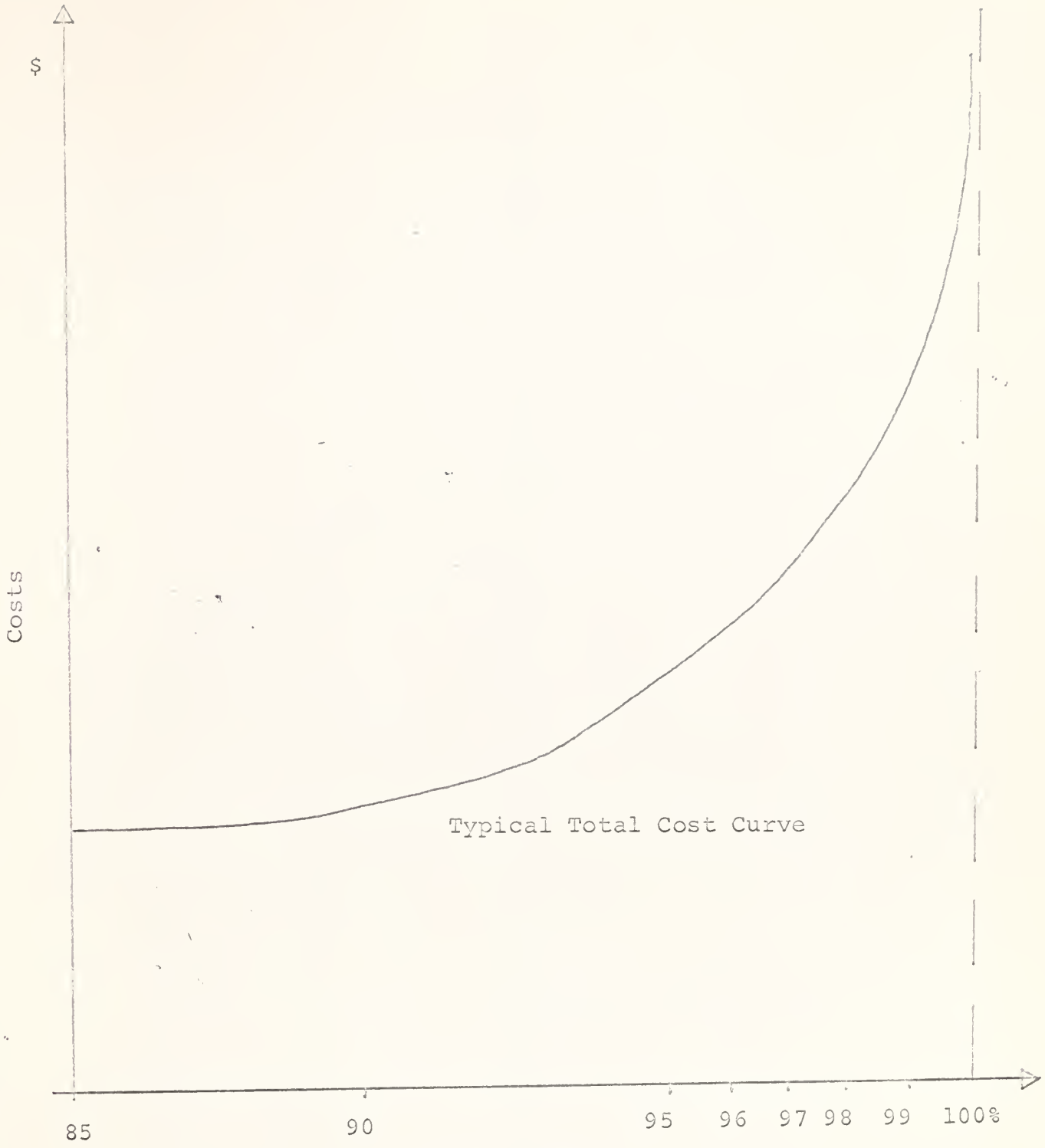
$
Costs
Typical Total Cost Curve
85
90
95
96
97
98
99
100%
Service Level

FIGURE 2

SELECTION OF SAMPLE

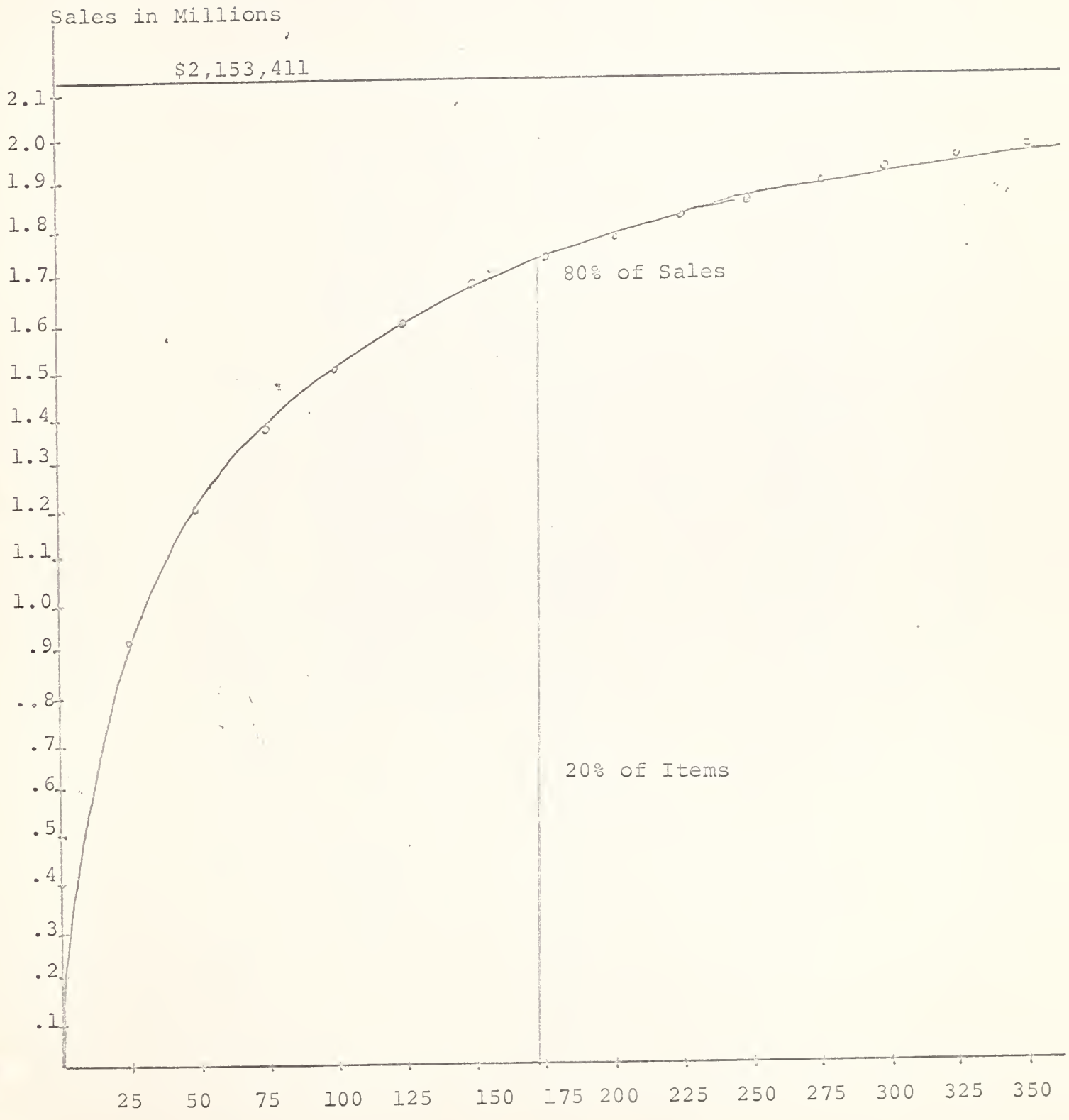

FIGURE 3

NUMBER OF ITEMS IN STUDY = 25

Item No.	Description	Size
207F	Old American	1/2 Gallon
252D	Calvert Extra	Fifth
418D	Barclays London	Fifth
410E	Fleischmann's	Quart
790D	La Boheme	Fifth
790F	La Boheme	1/2 Gallon
39D	Jim Beam	Fifth
302D	MacNaughton's	Fifth
70C	Walker's Deluxe	Pint
83D	Old Crow Traveler	Fifth
409D	Gilbey's London	Fifth
72F	Early Times	1/2 Gallon
80D	Jack Daniel-Black	Fifth
206B	Kessler	1/2 Pint
206C	Kessler	Pint
206D	Kessler	Fifth
333D	Cutty Sark	Fifth
312D	McMaster's	Fifth
809X	Gallo Ripple, Red	Tenth
229C	Seagram Seven Crown	Pint
229D	Seagram Seven Crown	Fifth
305D	Seagram V.O.	Fifth
416D	Gordon's	Fifth
209F	Lewis & Clark	1/2 Gallon
946F	Lewis & Clark Vodka	1/2 Gallon

FIGURE 4

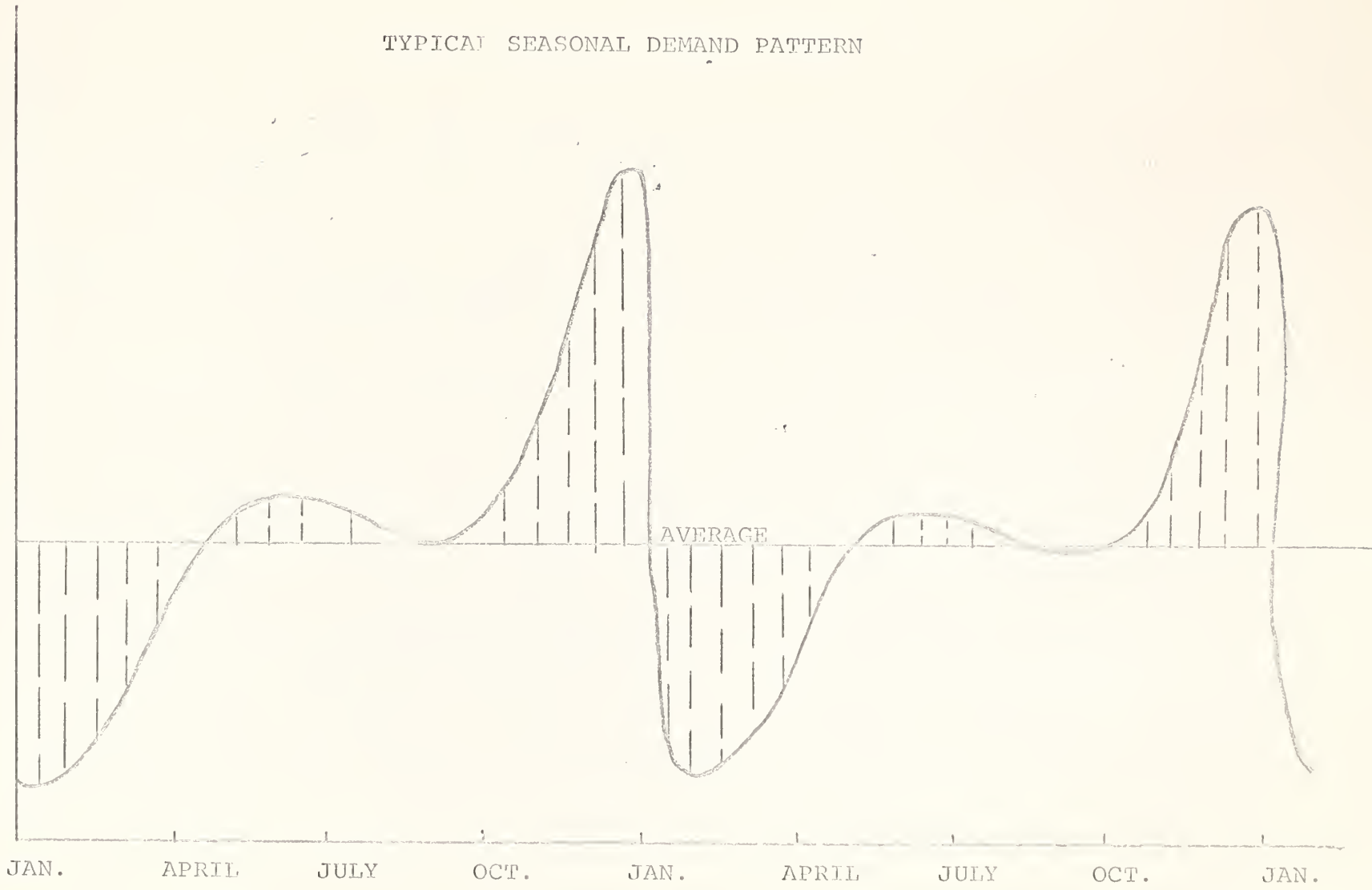
TYPICAL SEASONAL DEMAND PATTERN
AVERAGE
JAN.
APRIL
JULY
OCT.
JAN.
APRIL
JULY
OCT.
JAN.

FIGURE 5

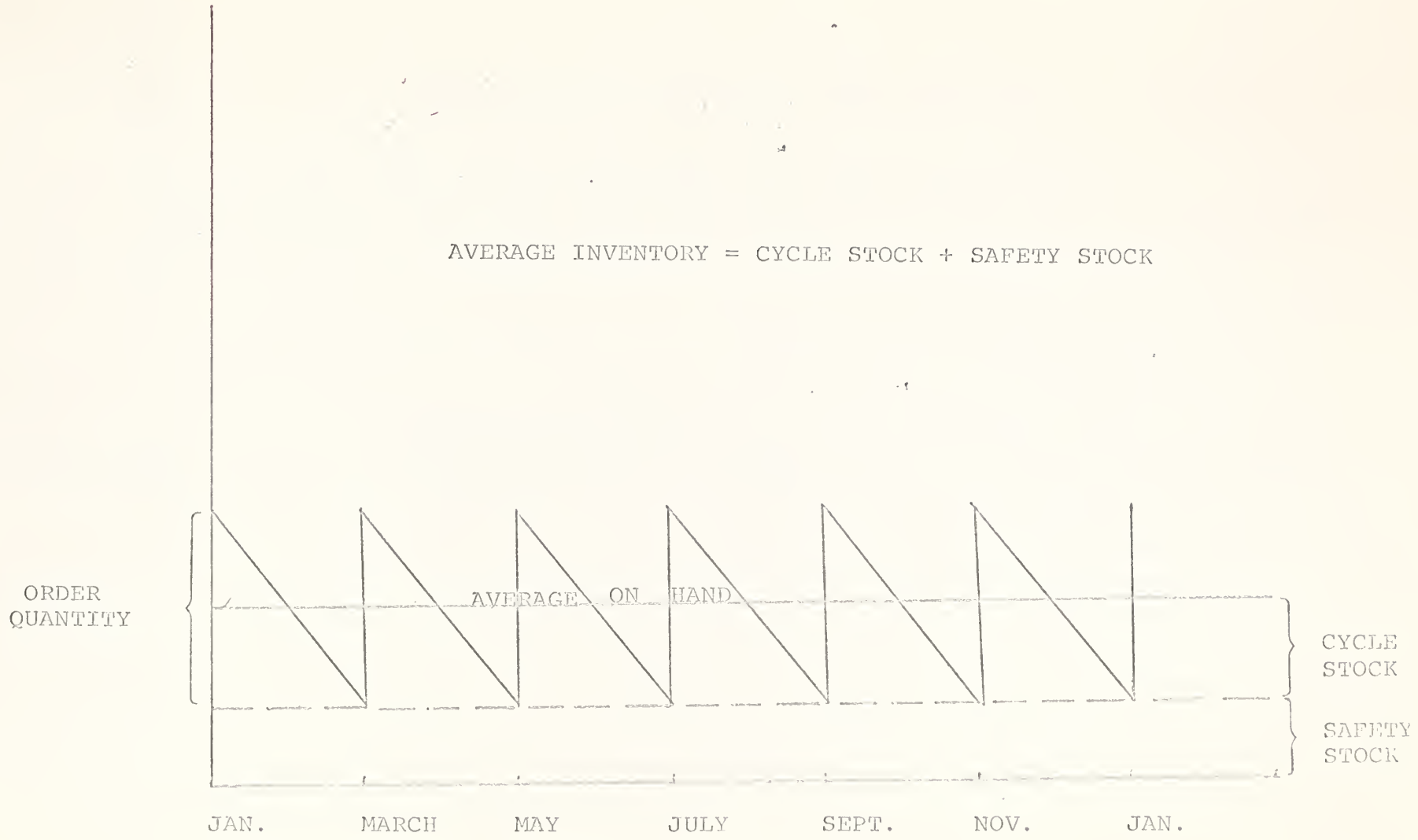
AVERAGE INVENTORY = CYCLE STOCK + SAFETY STOCK
ORDER QUANTITY
AVERAGE ON HAND
CYCLE STOCK
SAFETY STOCK
JAN.
MARCH
MAY
JULY
SEPT.
NOV.
JAN.

FIGURE 6

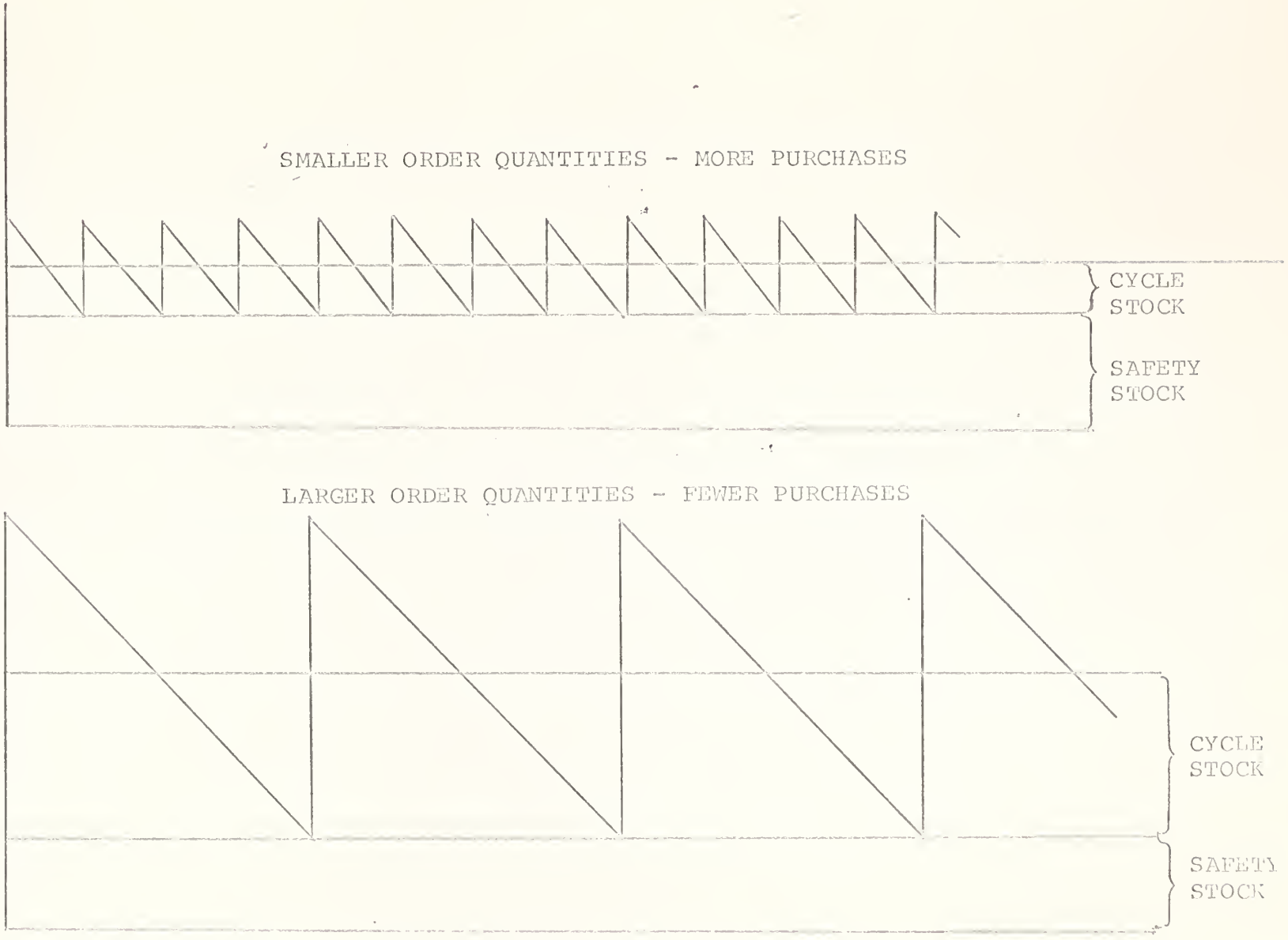
SMALLER ORDER QUANTITIES - MORE PURCHASES
CYCLE STOCK
SAFETY STOCK
LARGER ORDER QUANTITIES - FEWER PURCHASES
CYCLE STOCK
SAFETY STOCK

FIGURE 7

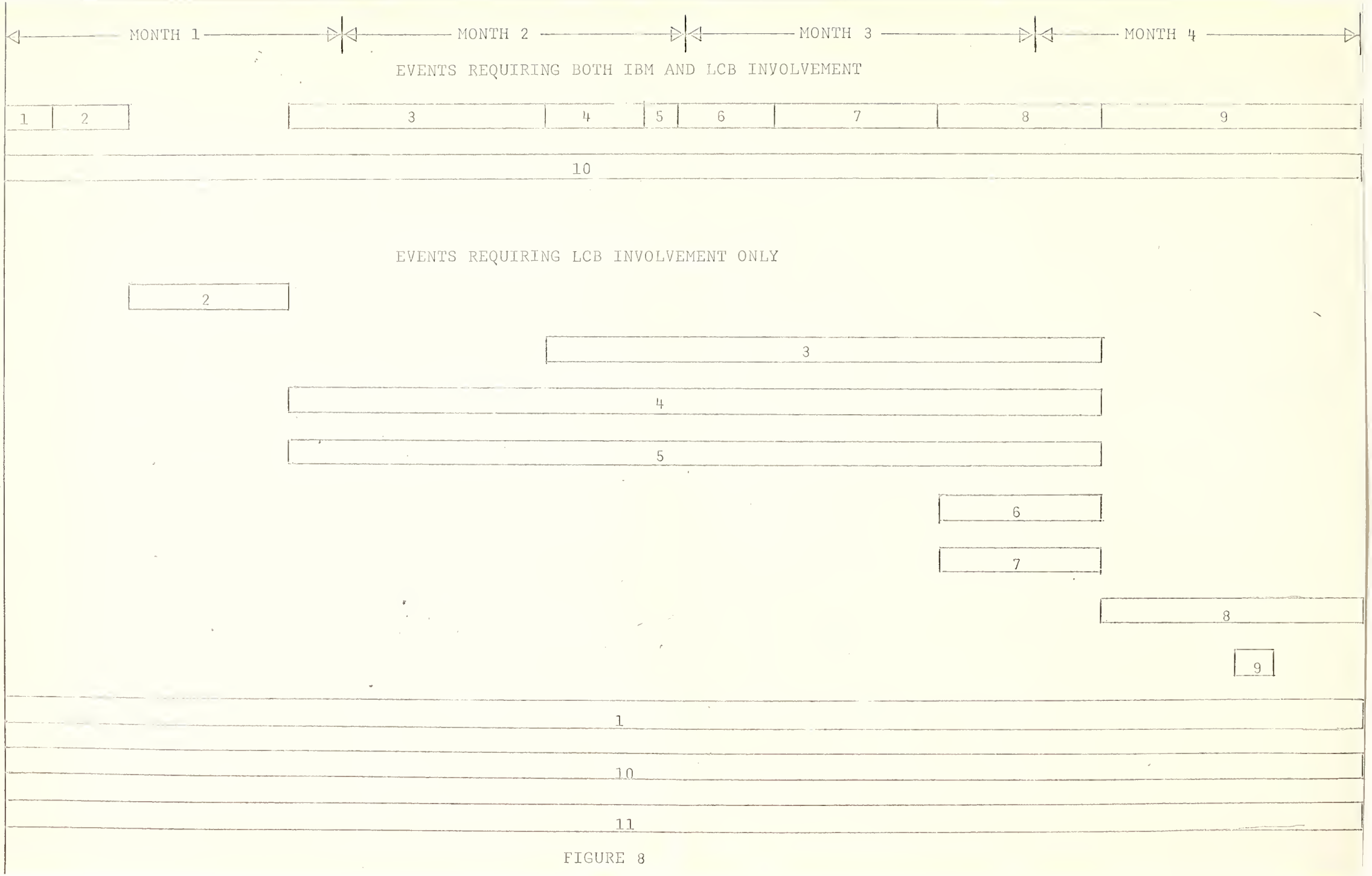
MONTH 1
MONTH 2
MONTH 3
MONTH 4
EVENTS REQUIRING BOTH IBM AND LCB INVOLVEMENT
1
2
3
4
5
6
7
8
9
10
EVENTS REQUIRING LCB INVOLVEMENT ONLY
2
3
4
5
6
7
8
9
1
10
11

FIGURE 8

LEVEL OF INVENTORY NEEDED TO
MAINTAIN SPECIFIED SERVICE
IN WAREHOUSE (25 ITEMS)

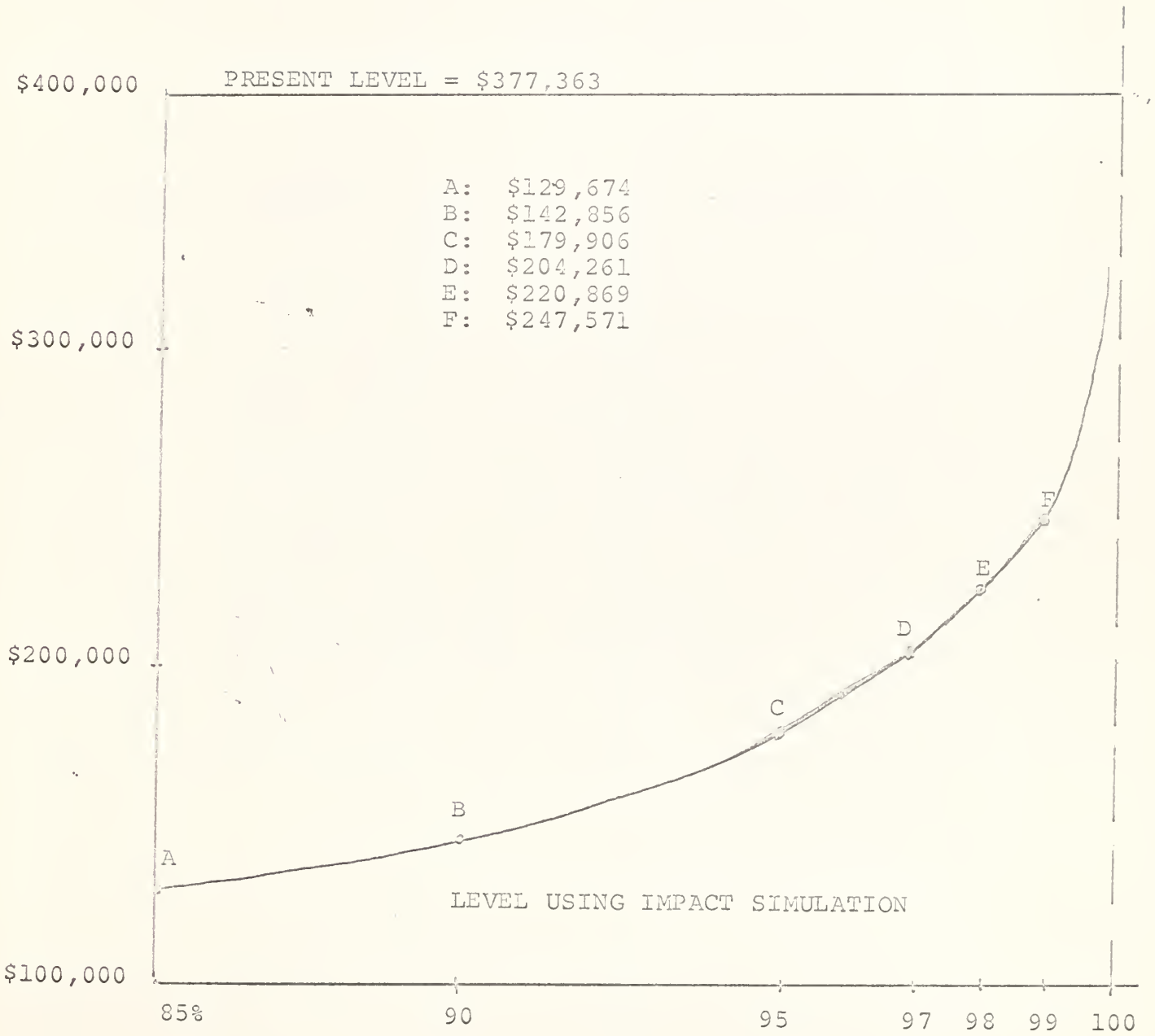

FIGURE 9

INCREASE IN PURCHASING COSTS: $ 381.00

INCREASE IN FREIGHT COSTS: $ 2,784.00

TOTAL INCREASE IN COSTS: $ 3,165.00

PRESENT AVERAGE STOCK (25 ITEMS): $377,363.00

IMPACT SIMULATION RESULTS - 25 ITEMS

SERVICE LEVEL	INVENTORY LEVEL	DECREASE FROM PRESENT	SAVINGS ON DECREASE	INCREASE IN COSTS	NET SAVINGS
85%	$129,674	$247,689	$17,338	$3,165	$14,173
90%	$142,856	$234,507	$16,415	$3,165	$13,250
95%	$179,906	$197,457	$13,822	$3,165	$10,657
97%	$204,261	$173,102	$12,117	$3,165	$ 8,952
98%	$220,869	$156,494	$10,955	$3,165	$ 7,790
99%	$247,571	$129,792	$ 9,085	$3,165	$ 5,920

FIGURE 10

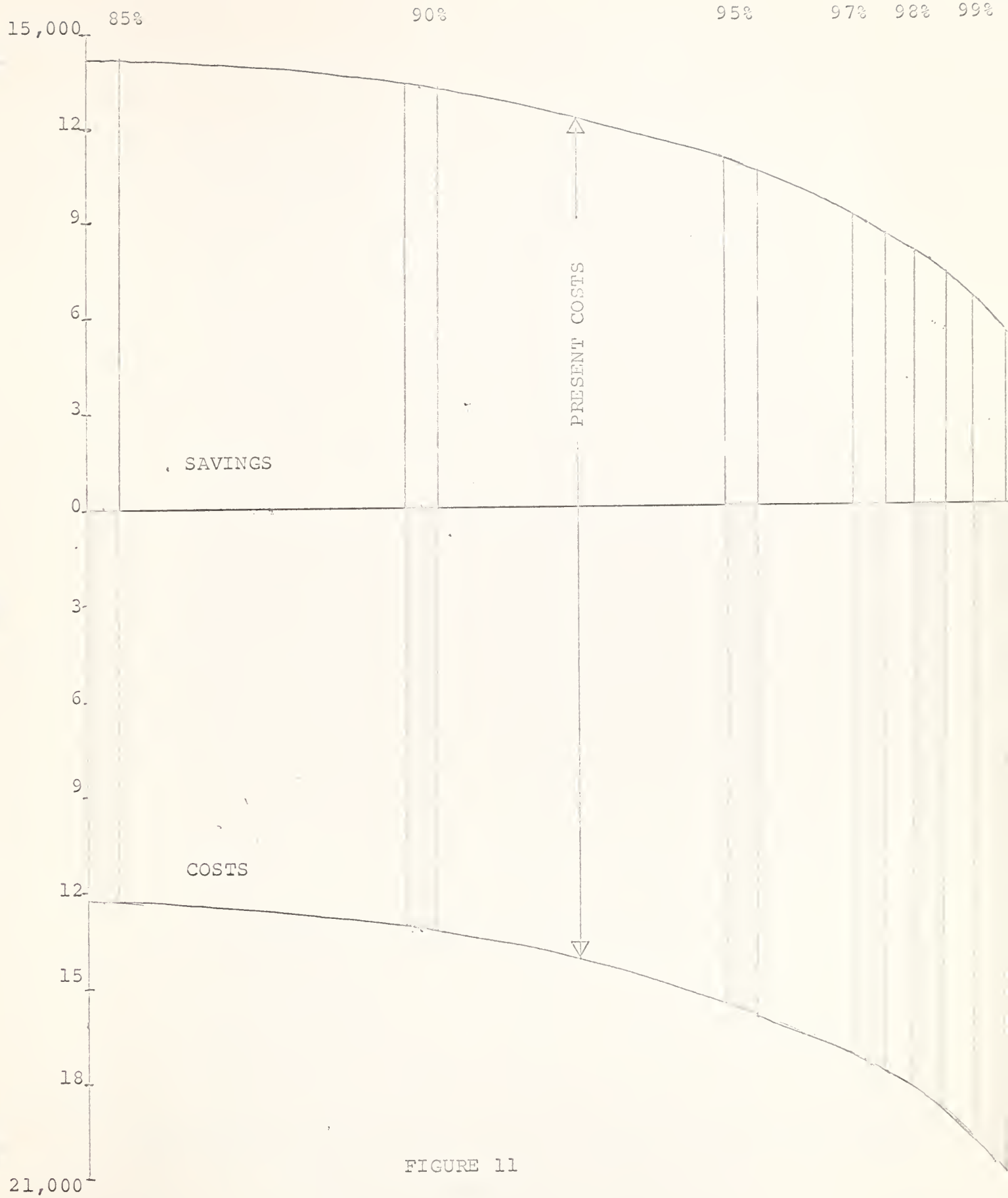
85%
90%
95%
97%
98%
99%
15,000
12
9
6
3
0
3
6
9
12
15
18
21,000
SAVINGS
COSTS
PRESENT COSTS

FIGURE 11

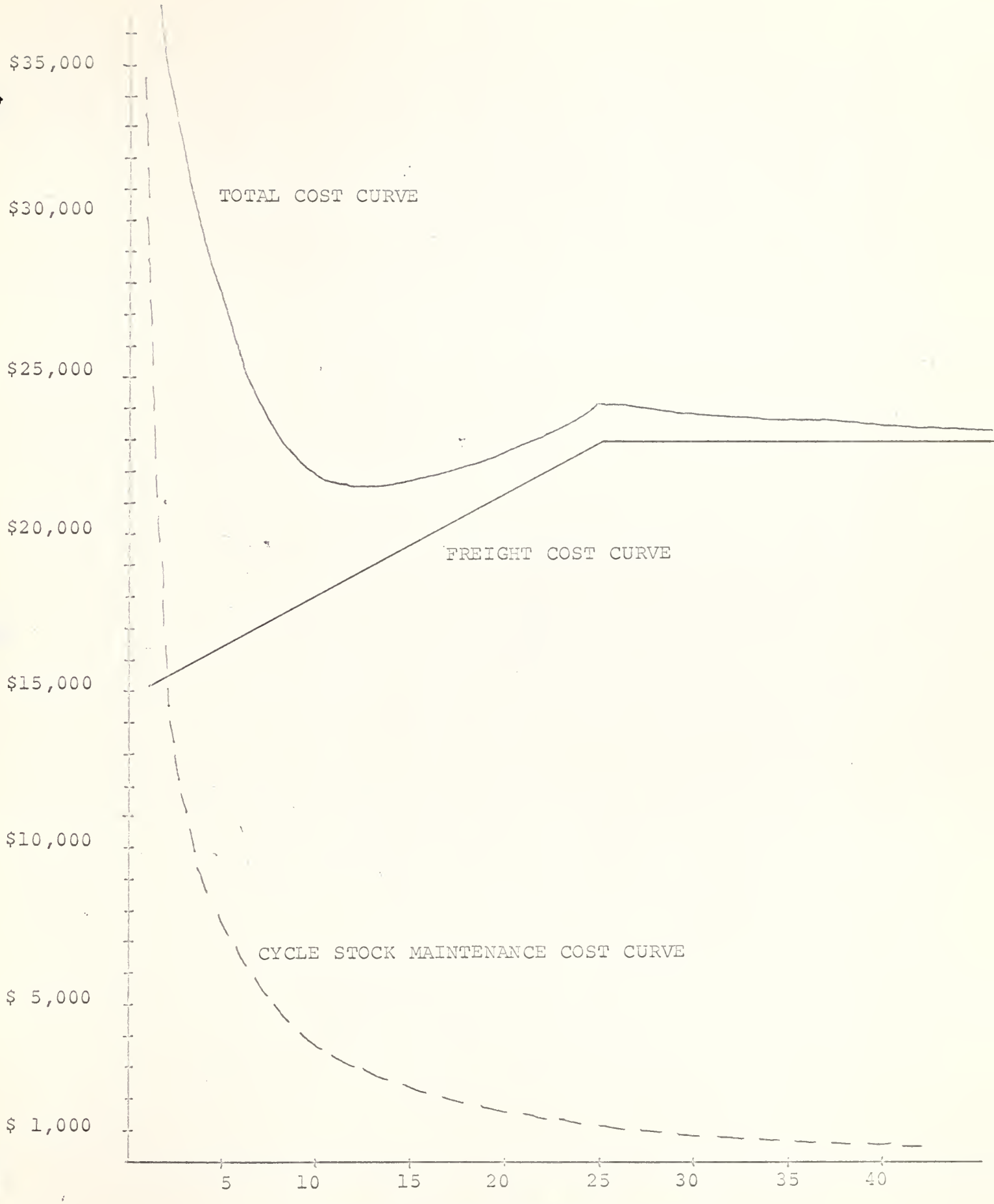
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$ 5,000
$ 1,000
TOTAL COST CURVE
FREIGHT COST CURVE
CYCLE STOCK MAINTENANCE COST CURVE
5
10
15
20
25
30
35
40
NUMBER OF TIMES ORDERED PER YEAR

FIGURE 12

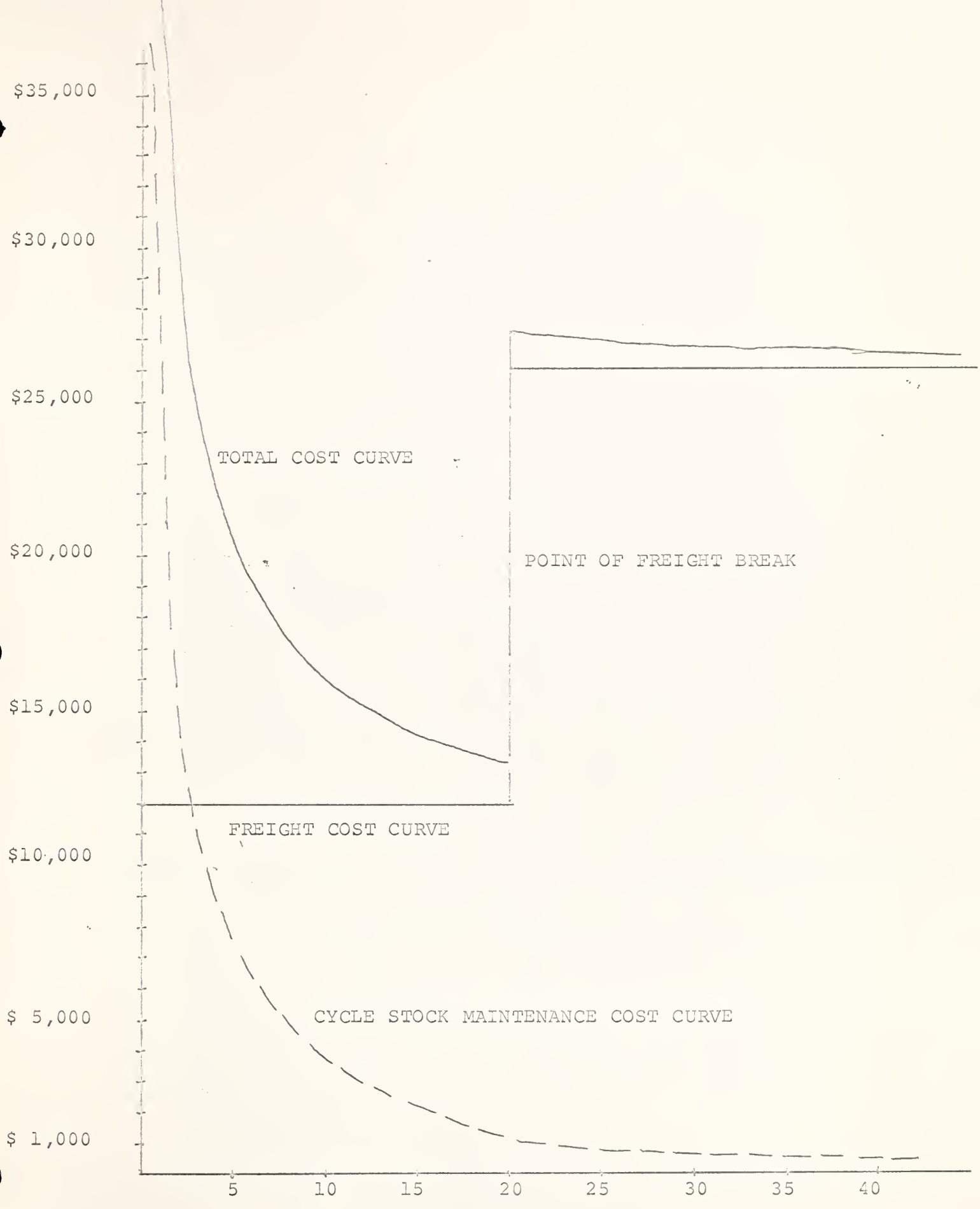
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$ 5,000
$ 1,000
TOTAL COST CURVE
POINT OF FREIGHT BREAK
FREIGHT COST CURVE
CYCLE STOCK MAINTENANCE COST CURVE
5
10
15
20
25
30
35
40
NUMBER OF TIMES ORDERED PER YEAR

FIGURE 13

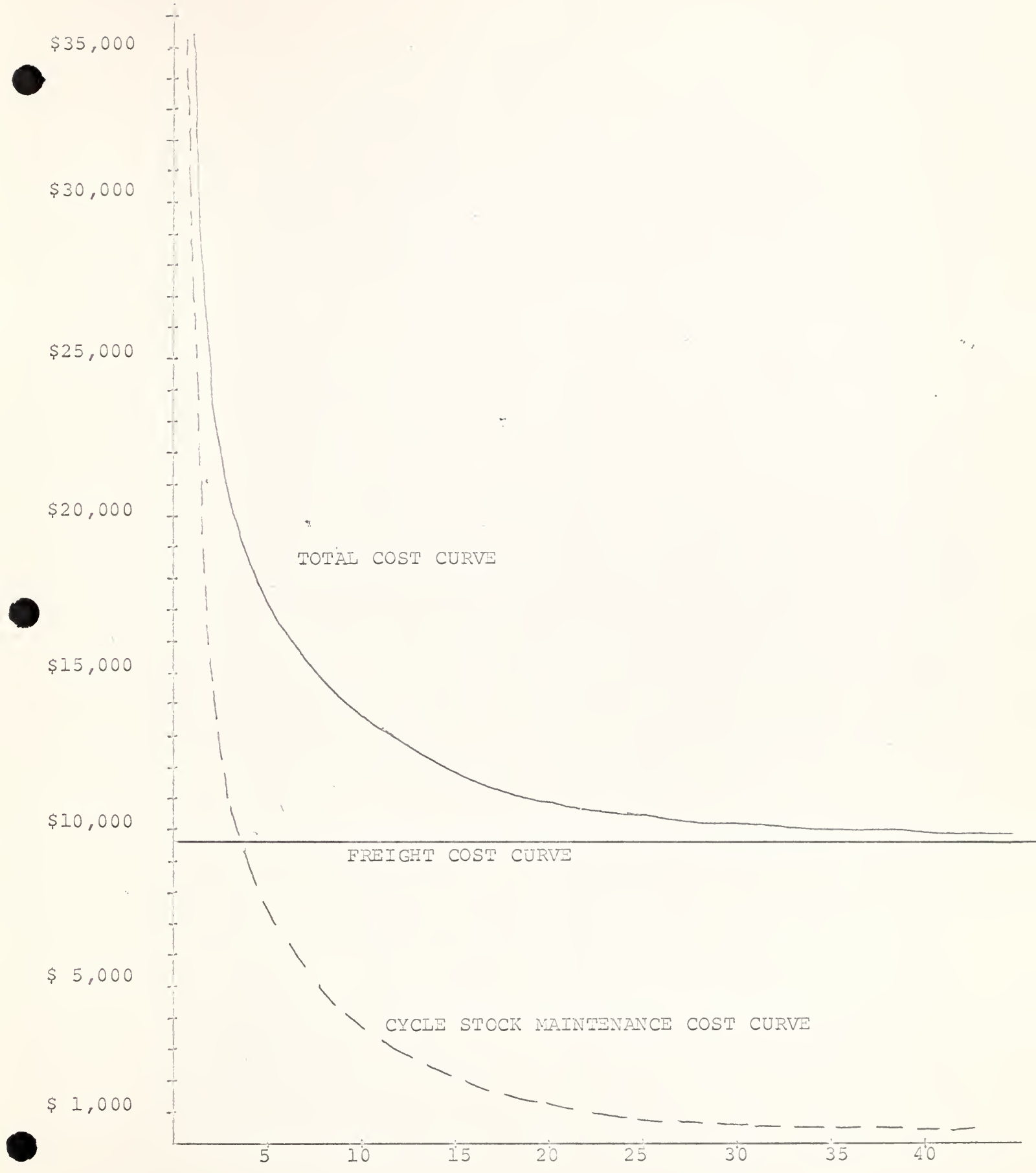
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$ 5,000
$ 1,000
TOTAL COST CURVE
FREIGHT COST CURVE
CYCLE STOCK MAINTENANCE COST CURVE
5
10
15
20
25
30
35
40
NUMBER OF TIMES ORDERED PER YEAR

FIGURE 14

SUMMARY OF

PROJECTION ANALYSIS

(SERVICE LEVEL = 95%)

PRESENT AVERAGE WAREHOUSE INVENTORY	$2,000,000
PROJECTED DECREASE BY USING IMPACT	$ 566,600
PERCENTAGE REDUCTION	28.3%
EXPECTED SAVINGS DUE TO REDUCTION	$ 39,662
EXPECTED INCREASE IN COSTS	$ 5,835
PROJECTED NET SAVINGS	$ 33,827

FIGURE 15

ACCOPRESS®

NO. 2507

BF - RED	BS - TURQUOISE
BG - BLACK	BQ - PALM GREEN
BD - LT. GREY	BX - EXECUTIVE RED
BP - LT. GREEN	BZ - DARK GREEN
BU - LT. BLUE	BA - TANGERINE
BY - YELLOW	BB - ROYAL BLUE

SPECIFY NO. & COLOR CODE

ACCO DIVISION OF GARY INDUSTRIES, INC
CHICAGO, ILLINOIS 60630